NOTES ON THE BIOLOGY OF TWO SPECIES OF RHAPHIDOPHORIDAE (ORTHOPTERA) IN TASMANIA

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Synopsis

Environmental conditions are given for four Tasmanian caves containing populations of *Micropathus* Richards. Food preferences of *M. cavernicola* Richards and *M. tasmaniensis* Richards are discussed, and it is shown that both species are omnivorous scavengers. In both species seven pre-adult instars are passed through. In November, all instars were present in the populations.

Introduction

To date only two genera of Rhaphidophoridae, *Micropathus* Richards (Richards, 1964) and a new genus (Richards, in press), have been recorded from Tasmanian caves, and nothing is known of their biology and habits. The new genus is known only from the Mole Creek district in northern Tasmania ; but *Micropathus* extends throughout the western half of Tasmania, and appears to be the dominant rhaphidophorid genus on the island.

Three species belong in the genus *Micropathus*. *Micropathus* n. sp. (Richards, in press) from Gunns Plains in north-west Tasmania, was discovered after the field-work in this paper had been completed, and appears to have a limited distribution. The other two species, *M. cavernicola* Richards and *M. tasmaniensis* Richards, occur throughout wide areas of the island (Richards, in press). In November 1966, a series of observations was made on their biology. Three areas in widely separated parts of Tasmania were selected for study. The caves examined were Marakoopa Cave and Little Trimmer Cave at Mole Creek, Cashion Creek Cave in the Florentine Valley, and Mystery Creek Cave at Ida Bay.

Table 1

Environmental conditions under which Micropathus *Richards occurred, November, 1966*

Locality	Latitude	Altitude (ft.)	Air Temperature in Caves (°F.)	Relative Humidity (%)	Species
Mole Creek ..	41·75	c.1400	48–49	86–92	*M. cavernicola*
Florentine Valley ..	42·60	c.1300	48–49	88–93	*M. tasmaniensis*
Ida Bay ..	43·25	c. 400	47–47·5	92–96	*M. tasmaniensis*

Habitat

Environmental conditions under which the two species of *Micropathus* occur are summarized in Table 1. Temperatures show little variation throughout each cave system and are among the lowest recorded from Australian caves containing Rhaphidophoridae (Richards, 1966 ; in press). Any effect altitude may have on temperature is counteracted by latitude, as there is a difference of

only 1·5°F. between Ida Bay and the other two areas. In all caves the relative humidity is very high. All four caves are situated in sclerophyll forest and contain streams which flood periodically.

Food preferences of Micropathus

In Tasmanian caves the food supply for cavernicolous arthropods is limited because of the absence of mammalian faeces with their associated guanobia. One of the main food sources is the large quantity of organic debris washed into caves during floods. Predation of one species on another also occurs.

Examination of crop content of both species of *Micropathus* collected from several different caves shows the insects appear to eat about equal proportions of plant and animal tissues, and are omnivorous scavengers. Crops contained large quantities of fungal hyphae and spores, as well as green algae, angiosperm tissues consisting of spiral, scalariform and pitted vessels, and unidentified chitinous arthropod remains. Algae can be obtained only round cave entrances ; but angiosperm tissues occur both inside and outside caves, as leaves and twigs are periodically washed into caves. At Marakoopa Cave, *M. cavernicola* was observed at night on vegetation outside the cave entrance.

In Cashion Creek Cave and Little Trimmer Cave partly eaten remains of *Micropathus* were found close to large aggregations of these insects. Rhaphidophorid mandible marks could be seen on several of the hind femora, which suggests cannibalism occurs. When placed alive in a confined space for several hours, small nymphs of *M. tasmaniensis* were attacked and eaten by large nymphs and adults.

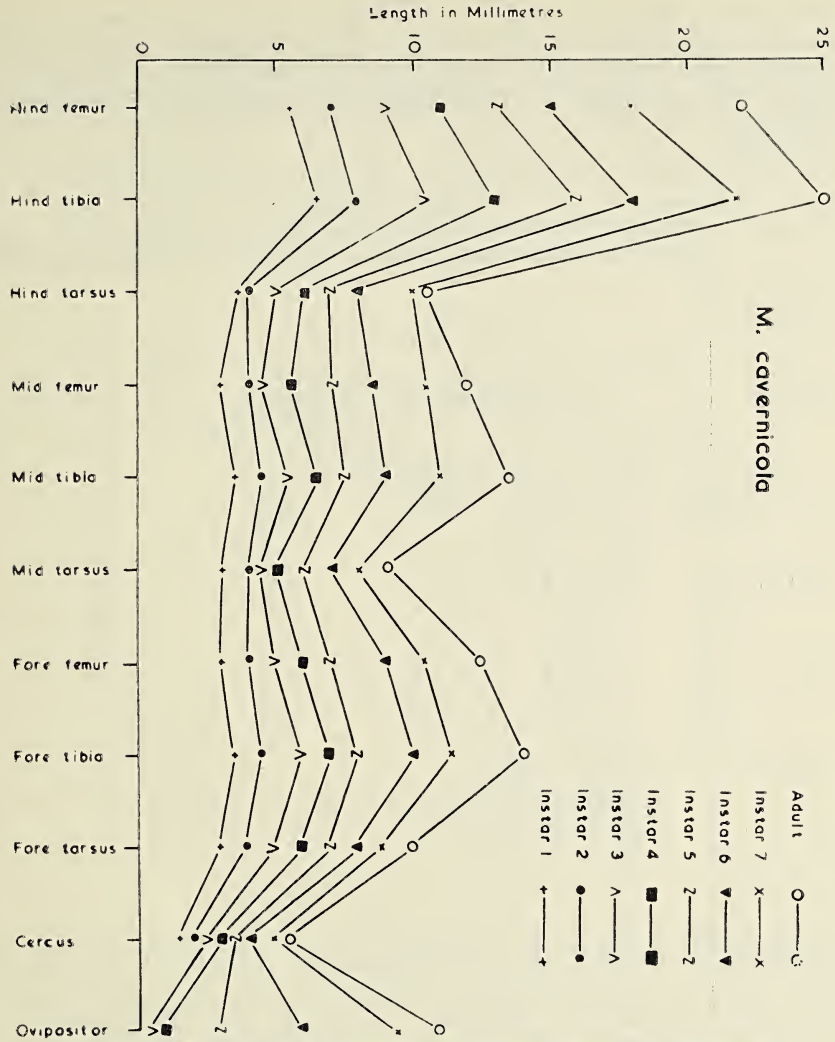
Number of instars in *Micropathus*

Neither *M. cavernicola* nor *M. tasmaniensis* have been reared under observation from egg to adult. In November 1966, field observations showed both species could be divided into a series of distinct groups ranging from first instar nymphs to adult insects. In all instars that could be sexed, there was a pre-

Table 2
Percentage increase growth in length in each instar in Micropathus cavernicola

	I mm.	II	III	IV	V	VI	VII	Adult
Hind Femur ..	5·5	27·3	28·6	22·2	18·2	15·3	20·0	22·2
Hind Tibia ..	6·5	23·0	31·3	23·8	23·0	12·5	22·2	13·6
Hind Tarsus ..	3·5	14·3	25·0	20·0	16·7	14·3	25·0	5·0
Mid Femur ..	3·0	33·3	12·5	22·2	27·3	21·4	23·5	14·2
Mid Tibia	3·5	28·6	22·2	18·2	15·4	20·0	22·2	22·7
Mid Tarsus ..	3·0	33·3	12·5	11·1	20·0	16·7	14·3	12·5
Fore Femur ..	3·0	33·3	25·0	20·0	16·7	28·6	15·0	19·0
Fore Tibia ..	3·5	28·6	33·3	16·7	14·3	25·0	12·5	21·7
Fore Tarsus ..	3·0	33·3	25·0	20·0	16·7	14·3	12·5	11·1
Cercus	1·5	33·3	25·0	20·0	16·7	14·3	25·0	10·0
Ovipositor ..			0·5 mm.	100·0	200·0	100·0	58·3	15·8

ponderance of females to males in a ratio of approximately 2 : 1. About 50 specimens of each species were collected. From these a series of measurements were made on the lengths of selected anatomical features in nymphs and adults. Sizes of individuals within each instar varied slightly so mean values have been used in all cases. These indicate that in both species seven pre-adult instars are passed through by male and female insects (Text-figs. 1, 2; Tables 2, 3).



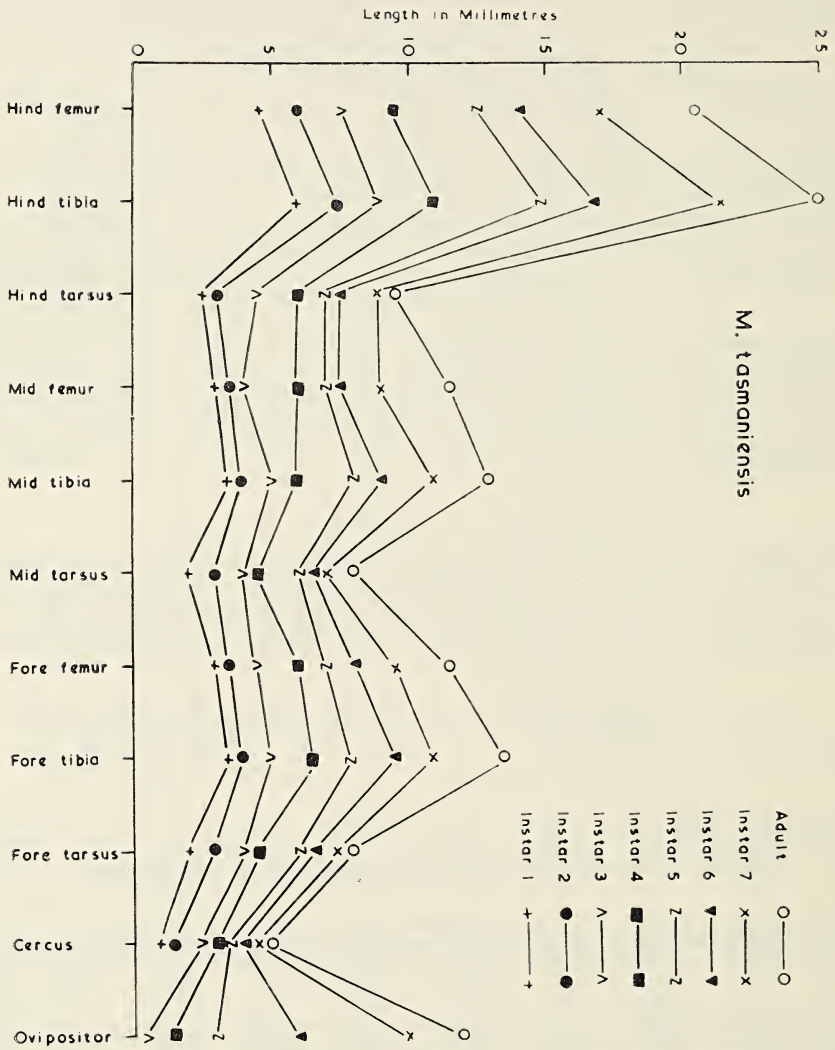
Text-fig. 1. Number of instars in *Micropathus cavernicola* Richards.

TABLE 3

Percentage increase growth in length in each instar in Micropathus tasmaniensis

	I mm.	II	III	IV	V	VI	VII	Adult
Hind Femur ..	4·5	33·3	25·0	26·6	31·6	12·0	21·4	20·6
Hind Tibia ..	6·0	25·0	20·0	22·2	36·3	13·3	26·5	16·3
Hind Tarsus ..	2·5	20·0	50	33·3	16·3	7·1	20·0	5·5
Mid Femur ..	3·0	16·6	14·3	50	16·6	7·1	20·0	27·7
Mid Tibia.. ..	3·5	14·3	25·0	20	33·3	12·5	22·2	18·2
Mid Tarsus ..	2·0	50	33·3	12·5	33·3	8·3	7·7	14·3
Fore Femur ..	3·0	16·6	28·6	33·3	16·6	7·1	18·7	21·0
Fore Tibia ..	3·5	14·3	25·0	30·0	23·0	18·7	15·8	22·7
Fore Tarsus ..	2·0	50	33·3	12·5	33·3	8·3	15·4	6·6
Cercus	1·0	50	66·6	20·0	16·6	14·3	12·5	11·1
Ovipositor ..			0·5 mm.	200·0	100·0	100·0	66·6	20·0

Observations were also made on the degree of development of male and female external genitalia. In all but the smallest nymphs, the stages in the development of the ovipositor in females proved a useful indicator in determining the number of instars present. The attempt to separate males into instars was less satisfactory.



Text-fig. 2. Number of instars in *Micropathus tasmaniensis* Richards.

To check whether an instar had been overlooked in either species, the logarithm of the linear measurements of the hind femora were plotted against the number of instars. Calculated values were obtained from fitted regression lines, and are given in Table 4. The approximation of the observed to the calculated measurements is sufficiently close to remove the possibility of an instar having been overlooked. It is suggested that this remarkably good fit is due to the unusual circumstances of all instars being present at the same time, thus being subjected to identical environmental conditions.

Discussion

The vegetation surrounding Tasmanian caves, and the fauna occurring in them have closer affinities with New Zealand than with mainland Australia. Most caves in New Zealand and Tasmania are situated in rain forest or wet sclerophyll forest, and have underground streams ; algae and bryophytes grow in abundance round cave entrances ; bats do not occur in the caves ; and Rhaphidophoridae and Mycetophilidae (Diptera) are the dominant cavernicolous species. Organic debris washed into caves partially compensates for the absence of guano and guanobia, both of which are important food sources for Rhaphidophoridae in mainland Australia and other parts of the world.

Table 4

Fit of Dyar's law to instar measurements of hind femora in M. cavernicola *and* M. tasmaniensis

Instar	*M. cavernicola*		*M. tasmaniensis*	
	Observed Length (mm.)	Calculated Length *	Observed Length (mm.)	Calculated Length *
1	5·5	5·9	4·5	4·8
2	7·0	7·1	6·0	6·0
3	9·0	8·6	7·5	7·4
4	11·0	10·4	9·5	9·2
5	13·0	12·6	12·5	11·4
6	15·0	15·3	14·0	14·1
7	18·0	18·5	17·0	17·4
Adult	22·0	22·4	20·5	21·6

Proportionality constant : 1·21 for *M. cavernicola* ;
1·24 for *M. tasmaniensis*.

* From regression line.

In Europe, Trichoptera and Lepidoptera are the main arthropods eaten by rhaphidophorids (Remy, 1931 ; Chopard, 1938), while in New Zealand Hemiptera and Diptera are eaten (Richards, 1962). In Tasmanian caves no Lepidoptera occur as they breed in and are closely associated with guano, and no Hemiptera have been recorded. Trichoptera and Diptera both occur in the caves, but no arthropod remains from rhaphidophorid crops have yet been identified.

The simultaneous occurrence of all instars in both *Micropathus cavernicola* and *M. tasmaniensis* is unusual, and this is the first record among Rhaphidophoridae. However, it is known that the length of the developmental period in rhaphidophorids varies considerably within a species (Richards, 1961). This, together with the presence of two generations in the population, will to a large extent explain the full range of instars in *Micropathus* in November 1966. It is probable that all instars are present only during spring and early summer when hatching is occurring and overwintering nymphs are maturing into adults.

With the addition of *M. cavernicola* and *M. tasmaniensis*, the exact number of pre-adult instars has been determined for nine species of Rhaphidophoridae. The number of ecdyses in these species ranges from six to eleven, but is most commonly from six to eight (Ramsay, 1964). Both species of *Micropathus* pass through seven ecdyses. Sexual dimorphism does not occur in *Micropathus*, the same number of instars being present in both males and females. The two species are approximately the same size, which agrees with Hubbell's (1936) conclusion that the number of pre-adult instars in the life cycle of Rhaphidophoridae is related to the size of the adult insect.

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